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ASTRONOMICAL VELOCITIES

APPARENTLY speeding away from the earth at the rate of 7,200 miles a second, a faint group of nebulae studied by the Mount Wilson Observatory astronomers sets a new astronomical record. Speaking before the Pacific Section of the American Association for the Advancement of Science on June 19, Dr. Edwin P. Hubble and Milton L. Humason told of their studies which make most previously measured astronomical speeds and distances fade into relative insignificance.

The nebulae studied form what is known as the Ursa Major cluster, and are in the bowl of the Great Dipper, near the star under the point where the handle joins the bowl. Though too far away to be studied in detail, each member of the cluster is undoubtedly a swarm of stars, like the milky way system of which the sun is part.

The observatory's 100-inch telescope, the largest in the world, was the instrument that revealed this high apparent speed. By making a time exposure of fifty hours, on nine separate nights, a photograph was obtained by Mr. Humason of the spectrum of the brightest nebula in the group. This proved to be similar to the spectrum of the sun. The dark lines crossing it, each indicating the presence of a certain element, were not in the position they would occupy if the light came from a terrestrial source. Instead they were displaced to the red end of the spectrum. Ordinarily such a shift is taken to indicate a motion of the light source away from the earth. Such a motion spreads the light waves out, making them longer, or redder. If the object is approaching, they are squeezed together and made shorter or more violet in color.

On such a basis, the shift observed by Mr. Humason was indicative of a speed of the nebula away from the earth of 11,500 kilometers (about 7,200 miles) per second. Previously he had discovered some other record high speeds, such as 7,000 kilometers per second for a group in the constellation of Coma Berenices, 5,100 for a group in Perseus, 3,400 for one in Pegasus and 900 for one in Virgo.

For some years Mr. Humason's colleague, Dr. Hubble, has been studying these nebulae in various ways. It was in 1924 that he announced his first results, which solved an astronomical problem of long standing by proving that these spiral nebulae are actual galaxies of stars, beyond our own system. Though this was done with a couple of the very closest of the nebulae, by methods which could not be applied to the fainter, smaller and more distant ones, he found that he could get a determination of their distance from a measurement of their size or brightness. The nebulae all seem to be of roughly the same size. The small clusters consist of small and faint nebulae, so apparently they appear small only because of their great distance. From comparisons of their size, he has determined the distance of those whose "speed" was measured by Mr. Humason.

Even before the study of the Ursa Major cluster was completed, a direct relationship was found between the apparent velocity and the distance; the farther away the faster the recession from the earth. Using this relationship, Dr. Hubble predicted that Mr. Humason would obtain an apparent speed for the group of about 12,000 kilometers per second, corresponding to its distance of 75 million light years. The most distant stars in our own system are of the order of a hundred thousand light years, a light year being equal to about six trillion miles. When the velocity of the Great Bear cluster came out at 11,500 kilometers, the prediction was abundantly justified. As the relationship holds very closely for all the cases which have been studied, it is believed that the method can now be reversed. By measuring the apparent velocity of a nebula, its distance can be determined.

Just what these high speeds mean is not certain. It is not likely that all the spiral nebulae are seeking to depart from the vicinity of our system, nor is it likely that the farthest ones should be invariably the fastest. More probable is the hypothesis that something happens to the light waves as they travel through space, which spreads them out in just the same way as a motion of the source. The curvature of space, proposed by the Einstein theory, by which space itself is curved in higher dimensions, just as a ball is curved in three dimensions, has been given as one cause of such an effect. At the recent meeting, Dr. R. C. Tolman, physicist at the California Institute of Technology, discussed the possible causes of the effect.

POWER DEVELOPMENT

MAN has nearly reached the limit of development of steam power and will soon discover a new method of transforming energy to his uses. This far-reaching prediction was made by C. F. Hirshfeld, research engineer, of Detroit, Michigan, in an address delivered in Berlin on June 17 before thousands of engineers from all parts of the world attending the World Power Conference.

Scientists can now calculate the limit of power production possible under theory yet to be applied. In fact, they could attain this limit if metals strong enough to stand the increasing pressures and temperatures were available, Mr. Hirshfeld explained. "If we may judge from human history," he said, "this means that somewhere around the corner of time there lies a radically different process for power development. It means that before we have quite reached the limit of possibilities with present methods the new method will appear as an undeveloped infant to be fought over and nourished and carried through the period of adolescence until finally we shall say, 'How simple, why did no one think of it before?' "

Mr. Hirshfeld did not attempt to indicate what the predicted development will be. Apparently he was not

thinking of power development possibilities which have already been projected, such as the gathering of heat from the sun or the utilization of temperature differences between surface and deep water in the tropics or between sea water and atmosphere in the Arctic to operate a boiler. He said:

"There is no saying where this new development will come nor from whose hands. But, if we follow the path that man has trod thus far, it ought to come out of the fundamental research now in progress or undertaken in the near future.

"With our inherited ideas regarding matter and energy, corpuscle and wave, continuity and discontinuity all thrown overboard or, at least, so modified as to make them all unrecognizable, we appear to have before us a boiling pot out of which something of epochal significance may arise.

"And it is at least conceivable that this may be something that will make obsolete our present power plants before we have had time to find and commercialize metals which will stand the torture to which we are preparing to subject them."

OPTICAL ENERGY

If man paid for optical energy at the rate charged for electricity for domestic use, his vision would cost him less than one trillionth of a trillionth of a cent per second. This energy used every second for seeing is the millionth part of the millionth of an erg. It takes about 1,000 ergs to lift a thirtieth of an ounce only half an inch.

Dr. Charles Sheard, director of physics and biophysical research of the Mayo Foundation at Rochester, Minnesota, spoke of these minute quantities before the American Optometric Association in convention at Boston. He said:

"The retina of the eye is one of the most sensitive energy receivers and detectors known. It may be thought of as a radio receiver, although it does not respond to stimulation by ordinary waves, for it is a very selective set and is tuned to radiant energy of wavelengths within a single octave, lying between four and eight ten millionths of a meter or yard. These waves, like radio waves, travel at a speed of 186,000 miles a second and are the shorter sisters of the much taller ones we have christened radio.

"The sensitivity of the eye is extraordinary. Employing the Einstein equation of the energy required to cause the emission of a single electron with a ray of green light, we may conclude that a single energy quantum for green light is sufficient to excite vision.

"This is saying that the liberation of a single electron in the retina by a green or blue light can excite the sensation of vision in the brain. A millionth of a millionth of an erg per second is the energy or power necessary for vision.

"Since it requires the millionth part of the millionth of an erg to cause the emission of one electron at the retina and thus to set up the sensation of vision, then we know that if these thousand ergs to which we have referred could be used up at the rate of a millionth part of the millionth of an erg, and if there were no dissipation or loss of energy, an eye would have something of the order of a million years of vision. Indeed, it seems almost incredible and inconceivable.

"But the millionth of a millionth of an erg is a mighty small amount of energy. No more startling, however, than the statement made by the American Nobel Prize winner in physics, when he says that the number of electrons contained in the quantity of electricity which courses through an ordinary incandescent lamp and for which one should pay, if such were possible, one hundred thousandth of a cent, is so large that if all of the several million inhabitants of Chicago were to begin to count out these electrons and were to keep counting them at the rate of two a second and if none of them were ever to stop, sleep or die, it would take them just 20,000 years to finish the task."

THE EFFECTS OF DEAFNESS

The individual who loses his hearing entirely, or even partially, is in danger of falling into one of two unhappy states. Either he may become sadly depressed, or else he may become suspicious.

Which way the deafened person is most likely to fall depends on his own personality, according to a report by Dr. Ruth Brickner, of New York, before the Federation of Organizations for the Hard of Hearing, which met recently in New York City.

The person who becomes suspicious is the type known to psychiatrists as a narcissistic person, because of his strong tendency to self-love. Such a man has always been unable to accept criticism, Dr. Brickner explained. He could not be wrong, and yet frequently complains of injuries and slights. He can not accept, or even believe, that he has become the victim of a serious disorder, and so when he gets into difficulties through his defective hearing he is quick to accuse the world of persecution and ridicule.

The man who becomes depressed is the type who has always gone through life feeling dissatisfied with his achievements and highly critical of himself. He has been unable to develop what Dr. Adolf Meyer so aptly calls "resting points of satisfaction." Such a man may rage at his deafness which restricts his freedom, but his rage takes the form of self-hatred.

Both types, if the condition becomes acute, shut themselves away from other people, the first because he suspects people of being unfair to him, and the second because he dislikes to trouble others with his conversational handicap. Extreme personality types and extreme reactions to deafness are not common, but each individual needs to recognize the tendencies and where they may lead.

Study of lip reading was recommended by Dr. Brickner as the first prerequisite to overcome isolation in deafness. Human beings happen to be social beings. Some deafened persons achieve success in social contact with other deafened persons, and in familiar environment, but become panic-stricken when they have to talk with hearing people. Others attain the greater victory of